The Fourth Revolution – long-term developments of containerized shipping

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Evolution and revolutions: scale and scope economies

A conceptually convenient way of depicting the history of liner shipping is as a combination of one, continuous evolution and several, successive revolutions. The evolution relates to the continuously increasing size of ships and ports in the pursuit of economies of scale. The revolutions relate to a series of technological breakthroughs, expanding the boundaries of the shipping system in the pursuit of economies of scope. The first revolution was the unitization of cargo, or containerization, focusing on the ship to shore transfer process and inducing the development of specialized ships and ports. The second was the expansion of containerization to land transport modes, or intermodalism, using the marine boxes for the entire ship to door transport process. This revolution was facilitated by the development of unit-trains with articulated, double stack railcars, on or near dock intermodal yards to handle them, domestic containers (in the US) and near dock transloading terminals to transfer the content of marine to domestic boxes, and hinterland "dry" ports, serving as extensions of the marine ones. The third revolution included the development of transshipment, or ship to ship transfer, linking together different shipping services and expanding the reach of container shipping to smaller ports.

The recently completed third revolution marked the final stage of the scope expansion of container shipping. Hence, the forthcoming Fourth Revolution, unlike the previous ones, is not predicted to center on technological breakthroughs for further expanding the system, but on re-arranging the existing system. The Fourth Revolution was described by this author in a series of papers published in 1999 and updated in 2003 . The revolution, as depicted there, revolves around a far reaching rationalization of the worldwide service pattern of shipping services intended to create a comprehensive, integrated network, defined there as the global grid. The core service pattern of this grid is cross-Panama, bi-directional (counter rotating) equatorial round the world (ERTW), functioning as the "ring road" for the major east/west trades, with the service only calling at six or seven global "pure transshipment ports" (PTP), strategically located at the intersection points with north/south routes. Complementary north/south services would have the dual role of handling their own traffic and feedering the east/west traffic. Additional feeder services might be needed for the final regional distribution to smaller ports. Accordingly, the total origin/destination trip might involve a total of up to five different services and five transshipments, two of which at the ERTW's PTPs. The main advantage of this service system would be the effective use of ships and ports; its main disadvantage would be the multiple handling of boxes (transshipments).

ERTW and PTPs

The two main components of the above depicted Fourth Revolution are the circular service pattern, the ERTW, and its ports of call, the PTPs. The advantage of a circular service pattern stems from the continuity of its route, which has no end points and respective switch backs. The circularity eliminates the need for double calling at ports at the end regions (east and westbound), resulting in a better utilization of ships' space and shorter transit times. The round the world rotation consolidates multiple trades into one service with a high traffic volume, which, in turn, provides for the deployment of the world's largest and most cost effective ships. The employment of counter rotating services also provides for better adjustment of ship size to the directional flow of traffic volumes. It was estimated that the ERTW based shipping system could handle about half of the total world's east/west trade.

The second component of the Fourth Revolution, PTPs, is critically important for the transshipment intensive shipping system. Since these PTPs are expected to only handle transshipment or ship to ship transfer, it was predicted that they would be based on a specialized handling system resulting in a much higher productivity and lower cost than in existing ports.

Obstacles to the Fourth Revolution

The Fourth Revolution, despite its radical name, seemed to be the logical next stage in the evolution/revolutions development path of liner shipping. The 2014 expansion of Panama Canal was expected to serve as its trigger. However, as early as 2006 it was observed that the revolution might be stalled because of two obstacles:

- The emergence of ships substantially larger than the new Panama locks; and
- The failure to develop cost effective, specialized PTPs.

The New Post-Panamax (NPX) ships defined by the new and expanded Panama locks, with 12,500 TEUs, are almost three times larger than the 4,500 TEU Panamax. But Maersk's new 18,000 TEU, Triple-E ships, soon to be deployed on the Asia/Europe trade route, are almost 50 percent larger than the 12,500 TEU NPX. Moreover, it is quite likely that the continuing evolution in ship size will not stop at 18,000 TEUs and larger ships might emerge within a few years (see discussion below). A second expansion of the Panama Canal to accommodate larger-than NPX ships is not envisioned for many years and, perhaps, might even be technically infeasible. Hence, the ERTW would not be able to deploy the largest and most cost effective ships of the future. Likewise, the massive transshipment to be generated by the Fourth Revolution could not be efficiently handled by existing ports, which are geared toward handling gateway traffic. Altogether, it seems that the bold concept of consolidating a large chunk of the world's east/west trades in a single, comprehensive ERTW service pattern is unlikely to be realized.

Continuation of direct services

The Fourth Revolution predicted a transformation of the current service pattern, mainly based on direct calls by mainline (mother) ships, to a pattern mainly based on indirect calls by feeder ships with extensive use of transshipment. Presumably, such a transformation should have taken place as a "natural" consequence of the substantial increase in ship size, even without the Fourth Revolution and its ERTW based global grid. Larger ships promote transshipment by: (a) allowing better exploitation of the size differentials between mother and feeder ships; and (b) reducing the number of ports that can handle them either due to insufficient traffic-generation or insufficiently large facilities.

Interestingly, despite the introduction of larger ships, no meaningful transformation in service pattern has taken place thus far. The service pattern of the shipping services on the world's largest trade route, Asia/Europe, is still based on direct calls at all major regional ports as it has been when ships were much smaller. Moreover, Maersk Line's AE10 service, which employs the largest ships presently in operations, the E-class with 15,000 TEU, has recently added a "detour" into the Baltic Sea. As a result, this service includes direct calls at 14 instead of 10 ports by the more common Asia/Europe services. Likewise, most recently, the G6 alliance has announced an extension of its Asia/Europe service to Gothenburg. As a result, this mid-size remote port, which previously was only served by feeders, has two direct weekly calls by Asia/Europe mainline services.

Emerging bi-regional shuttles services

While the overall pattern of the Asia/Europe services, based on direct calls, has been kept unchanged for many years, an interesting modification has been taking place recently, eliminating calling at ports en route. The traditional multi-trade services commonly referred to as pendulums, have been gradually converting into single-trade, bi-regional shuttle services. For example, a few Asia Far East/North Europe services have eliminated en route calls in South Asia, the Middle East and the Mediterranean and only calling at ports in the two end regions. The en route regions, in turn, are also served by dedicated bi-regional shuttle services such as Asia Far East/Mediterranean, or south Asia/North Europe. The latest addition to this trend is the Southeast Asia/Middle East dedicated service announced by UASC (AGX). This transition from multi-trade to single trade services was triggered by the general growth in trade volumes and, especially, the recent creation of "super" alliances, producing sufficient traffic volumes to fill large ships.

Revised Fourth Revolution based on bi-regional shuttle services

The revised Fourth Revolution, the subject of this paper, is based on the same principles of the original Fourth Revolution, except that the ERTW is replaced by bi-regional shuttles as the core service pattern. The principle guiding both revolutions remains the same: comprehensive rationalization of the service pattern. In fact, the need for such rationalization is more urgent today, when ship size is reaching 18,000 TEUs, than in 1999, when the largest ship was Maersk's S-class with nominal capacity of "only" 6,600 TEUs.

The Revised Fourth Revolution is based on further transformation of existing bi-regional shuttle services. The present shuttles are multi-port, with the mother ship calling directly at several ports at each end region. In contrast, the envisioned shuttles of the Revised Fourth Revolution will only call at a single PTP in each end region, whereby the entire ship is turned around, and the regional distribution is provided by feeder services. The revised revolution implies the full application of the "classical" hub and spoke concept, with mainline services only calling at two ports and the rest of the ports served by feeders. This, indeed, is the most cost effective service pattern available; assuming the cost of transshipment at these hub ports can be substantially reduced. Also, the single hub shuttles do away with the multiple transshipments of the original Fourth Revolution. Another advantage is that most of the transshipment is concentrated in specialized PTPs instead of distributing it over gateway ports as is presently the case (see below).

The revised Fourth Revolution, very much like the original one, is dependent on the development of specialized PTPs to quickly and efficiently turn around 18,000 TEU ships, which cannot be accomplished by existing handling technology. Hence, both revolutions require the development of a specialized handling technology for PTPs.

Transshipment in present terminals

Mixing gateway and transshipment traffic

Most of the transshipment traffic is currently handled by ports primarily designed to handle domestic (gateway) traffic. The gateway traffic is, to a large degree, captive and therefore can be charged full cost. In contrast, transshipment is "foot loose" and can be shifted overnight to competing ports, including those located far away. Therefore, transshipment is usually only charged marginal cost and, accordingly, treated as secondary to the primary gateway traffic.

Figure 1 presents indicative data on the share of transshipment in a sample of North European and Mediterranean ports. As shown there, all major ports of North Europe and the Mediterranean handle significant volumes of transshipment traffic; this also is the case in most ports worldwide, with the exception of the US. It is unlikely that these ports will develop a specialized handling system to transshipment, being considered by them as secondary. It is also interesting to observe that transshipment exceeds 90 percent only at three ports (inside the red frame), justifying the definition of then as PTPs.

Ship to ship versus ship to shore handling system

There are important operational differences between the handling systems of transshipment and gateway traffic, or between ship to ship and ship to shore transfers:

- Land interface – Ship to ship transfer does not require a gate for processing trucks, pre-gate parking for trucks, on dock intermodal yard for trains, and major road and rail connections;

North Europe		Mediterranean	
Bremerhaven	61%	Malta	95%
Hamburg	33%	Cagliari	95%
Antwerp	32%	Algeciras	90%
Rotterdam	32%	Taranto	89%
La Havre	26%	Damietta	87%
Zeebrugge	26%	Gioa Tauro	77%
		Port Said DDE	57%
		Barcelona	37%
Policy Research Corp 2010; HSH Nordbank 2010, Asher 2012		Valencia	31%

PTPs

Figure 1: Share of trannshipment traffic

- Selectivity – Ship to ship, or mother to feeder transfer, involves groups of containers, all sharing the same origins and destinations, while ship to shore transfer involves a single container;
- Control – In ship to ship transfer, the entire handling process is under the control of a shipping line while in ship to shore transfer, the shore side is controlled by cargo owners; and
- Dwell Time – In ship to ship transfer the dwell time between mother and feeder is shorter than in ship to shore transfer, since there is no need for clearing Customs, paying freight and port charges, arranging for land transport, etc.

Terminal automation and transshipment

Despite the differences between the handling systems of transshipment and gateway traffic, most of the transshipment is presently handled in terminals designed for handling gateway traffic. Because of shortage in waterfront land, these terminals are often created through costly deep-water reclamation. Accordingly, the main objective of the recently introduced automation of yard operations is to reduce the amount of terminal land through densification of the storage area, along with reducing labor cost and increasing productivity.

Figure 2 presents a typical layout of an automated terminal based on automated stacking cranes (ASCs), with two optional yard arrangements, parallel or perpendicular to the berth. The arrows in this figure depict the 3 main transfer processes performed at the terminal berth: (a) ship to yard (import); (b) yard to ship (export); and (c) ship to ship (transshipment). For illustration, the transshipment is presented in this figure by a double-headed arrow between mother and feeder, as if boxes are moving directly between these ships. Such a direct move is unconceivable in automated terminals whereby the dock area is exclusively used for traffic lanes and no interim storage is allowed there. In reality, transshipment in automated terminals is handled exactly like gateway traffic: first, the discharged box is transported from ship-side to the yard and temporarily staged there until being picked up and stored by the ASC; second, the box is retrieved by the ASC, temporary staged and transported back to the ship side for loading onto the ship. Accordingly, transshipment, or a ship to ship transfer in automated terminals, involves double handling.

A second problem of handling transshipment at today's automated terminals relates to the utilization of their most precious resource -- waterfront land. Most of the transshipment is presently handled in terminals designed to handle domestic traffic, since it is by far the most important traffic component. In these terminals, as seen in Figure 2, about 40 percent of the area is devoted to the land-interface. This area has no use for transshipment.

Productivity of automated terminals

A third, and perhaps the most critical problem of automated terminals, is their relatively low productivity. The productivity of the automated terminal shown in Figure 2 is constrained by

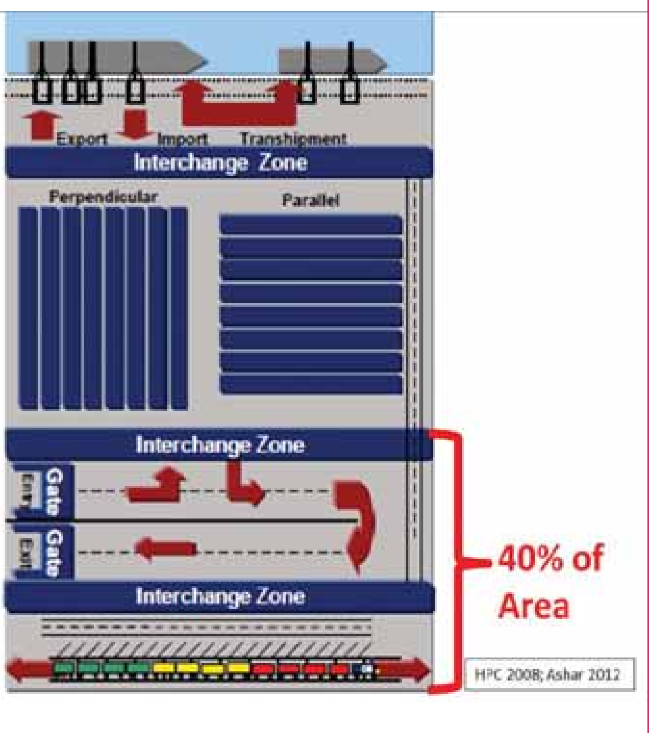

Figure 2 Layout of automated terminal

the yard system. The yard needs to simultaneously support both the ship side and land side operations, which limits the number of yard cranes that can be allocated for the ship side. This limitation is most severe in the more popular perpendicular yard arrangement, even when using nested yard cranes (Hamburg's CTB). Another constrain on productivity is the traffic congestion in the roadways between ship and yard, especially in larger terminals with longer distance traveling, where bulky shuttle carriers (small straddle carriers) are used to transport containers between yard and ship. Turning around an 18,000 TEU ship, as mandated by future shuttle services, would take three to five days if automated terminals reach productivity of 250 too 300 moves per hour (which is considered the upper limit achievable in such terminals). This undermines the feasibility of the entire shipping system Altogether, it seems that automation is not applicable for PTPs.

Floating pure transshipment terminals

Barges for storage and transport containers

As discussed above, automated terminals, designed for handling gateway traffic, cannot serve as the PTPs of the revised Fourth Revolution. For this, there is a need for a specialized handling system, taking advantage of the main characteristic of transshipment traffic -- moving groups of containers between ships. This, in turn, cannot be performed on land but only by water, using barges. Accordingly, future, specialized PTPs could be based on floating yards, or barges, for storing and moving containers.

Figures 3 and 4 depict a section and an elevation of the proposed design of a floating PTP. Figure 5 presents the overall layout of this terminal, using the Port of Algeciras as an example (the proposed layout and location of this terminal is the sole opinion of this author and is used here only as an illustration for the concept).

As seen in Figures 3 and 4, the STS crane is similar to conventional gantry cranes used in land based terminals, except that the roadways between crane legs are designed for barges instead of trucks. Likewise, the yard is not land based but water based, whereby barges are stored. These barges serve the dual role of: (a) horizontal transport vehicles of boxes between mother and feeder ships; and (b) intermediate, inter-ship storage device of boxes. The main advantage of barges is their ability to move groups of boxes together. This indeed is the case in ship to ship transfer, where one mother ship is typically "broken-down" into several feeder ships. For example, in the case of an 18,000 TEU mother served by five feeders each calling five ports, the average number of boxes moving between the mother and each of the 25 ports is 720 TEUs in each direction (18,000 per 25).

The configuration of the barges in the above figures are roughly based on common, square shaped Mississippi River "Jumbo" barges, with an arrangement of 10 by 4 by 4 TEU, or a total of 160 TEUs per barge (about 2,000 deadweight tonnage). Accordingly, a full discharge of an 18,000 TEU ship requires 112 barges (18,000 per 160). The ship to barge gantry cranes are conventional, although with a wider gauge of about 50 meters, which is not much different than the 42 meters of recent cranes. The cranes also have a cantilever of about 35 meters, allowing a total of eight rows of barges. This arrangement seems sufficient to provide the required selectivity, with each barge destined for a specific feeder and, desirably, specific destination port. The barges are moved along the mother ship by a special pulley system, similar to that used in the Mississippi River's grain terminals. The barges are stored (parked) according to their destination ports in a protected water area, referred to in the US as fleeting area. For the shuttling between the fleeting area and the dock, barges destined to the same ship are tied together, forming a train (called tow in the US) and pushed by a boat. Figure 6 presents an aerial picture of a typical fleeting area in the Mississippi River with hypothetical sorting of barges by feeder port destinations, based on the example of Algeciras. Figure 7 presents a picture of a tow of barges in the Mississippi River. The use of Mississippi River barges here is only for illustrating the floating terminal concept; it could well be that larger barges (six wide) would be more stable and better suited especially if triple tandem STS cranes are used. An operational simulation is required to determine the optimal size of barges, including the possibility of using a modular, flexible design, for example, assuming that two smaller barges can be tied to form a larger one.

The operation of the floating terminal is quite simple. The boxes from the mother ship are discharged onto barges according to their final destinations; the barges are towed away from ship side to the fleeting area and parked there according to destination ports; when the feeder ship arrives, the barges are towed back to ship side and the boxes are loaded onto the ship. Accordingly, the entire ship to ship transfer involves only two lifts, both performed by STS cranes. In comparison, the full ship to ship cycle at a land based, automated terminal based on shuttle carriers and ASC, involves eight lifts: two by the STS, four by shuttle carriers and two by the ASC cranes. Some limited shuffling of boxes may be needed in the floating operation due to changes in box destinations while already en route. These could be performed by floating cranes, such as that shown in Figure 8. It could well be that, as is the case in Algeciras, a small percentage of the traffic, will be gateway (domestic) traffic. The domestic traffic, much like the transshipment one, will be staged on barges, but instead of being towed to the fleeting area, it will be towed to a local, land based barge terminal.

A preliminary calculation indicates that the cost of barges would be much lower than the respective cost of developing a land based storage yard, especially in deep water and installing yard equipment. Likewise, the operating cost of transshipment in the floating terminal is expected to be a fraction of that in a land based terminal, because of the elimination of the double handling. Still, the main saving in the floating design would be in ship cost, as will be seen in the following section on productivity.

Productivity of a floating PTP terminal

The use of barges for horizontal transport of containers facilitates the use of tandem and triple lifting in the transshipment, ship to ship transfer operation, where the matching of boxes is simple, since many boxes have the same destination. Moreover, "dumping" the entire ship in a single terminal simplifies ship handling, allowing the deployment of more cranes per ship and a higher percentage of dual cycling, resulting in significantly higher productivity. For example, employing nine STSs with tandem lift (four TEUs) throughout the entire operation with 50 percent dual cycling, would result in productivity of 1,620 TEUs per hour (nine cranes multiplied by 30 moves per hour multiplied by four TEUs per move multiplied by 1.5). With triple lift, the productivity could reach 2,430 TEUs per hour. At these productivities, an 18,000 TEU ship can be turned around (with twice as many18,000 TEU moves) within one day! A berth dedicated to handling such ships on a daily basis could produce 13 million TEUs annually. Such productivities are way beyond those achievable in land based terminals.

Gibraltar / Singapore shuttle

Figure 9 shows the service route of Maersk's primary Asia/Europe service, the AE10 provided by Maersk's largest, 15,000 TEU E-class ships. As shown in this figure, the AE10, as well as almost all current Asia/Europe services, includes long regional legs in both North

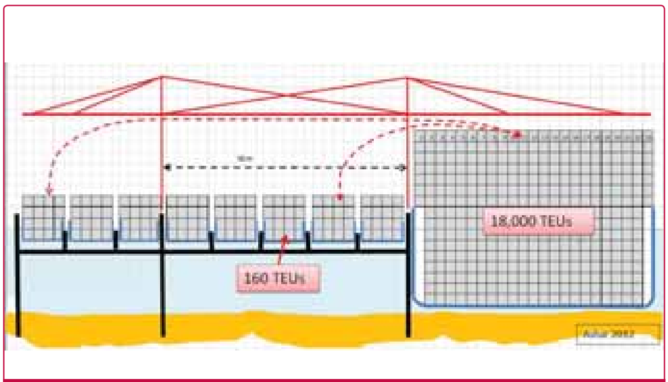

Figure 3 Floating pure transshipment port (PTP) - cross

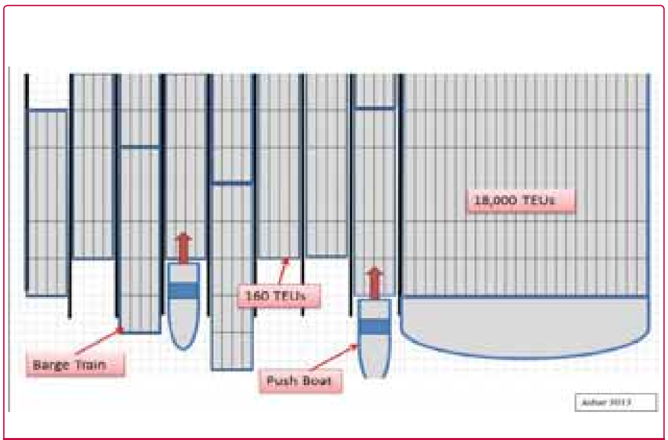

Figure 4 Floating pure transshipment port (PTP) -- elevation

Figure 5 Algeciras' floating pure transshipment port (PTP)

Figure 5 Algeciras' floating pure transshipment port (PTP)

Figure 7 Mississippi's fleeting area

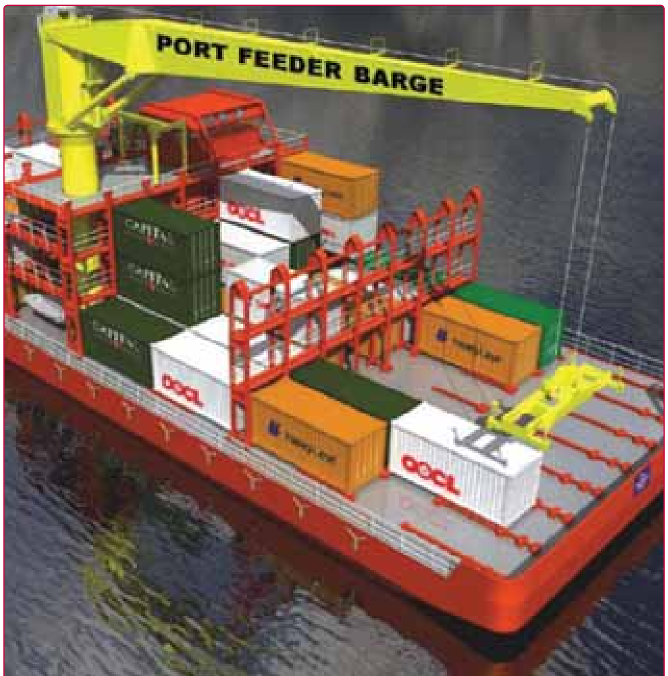

Figure 8 floating barge crane

Figure 9 Maersk Line's Asia / Europe AE10 service

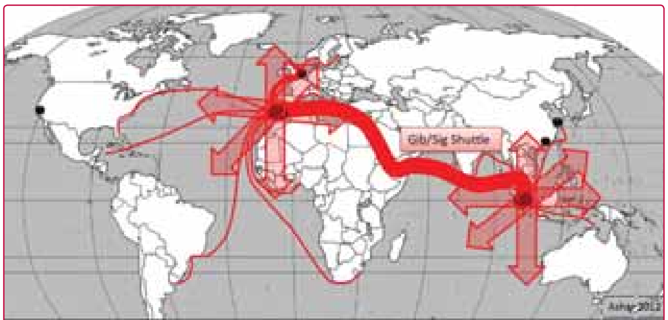

Figure 10 Gibraltar / Singapore shuttle

Europe and the Far East. Indeed, ships spend about half of their rotation time on these legs, most of it at regional ports. Accordingly, a typical Far East/North Europe rotation requires ten ships (AE10 employs 11 ships because of the additional Baltic Sea tour). Moreover, as illustrated by the double headed arrows, because of the switch backs, regional ports are either called once, resulting in long transit times for boxes moving in the opposite direction; or called twice, first for the inbound and second for the outbound traffic, resulting in waste of ship's time and additional port costs. Altogether, the current "milk run" of large, mother ships between fiuve or more regional ports on each end is very costly.

The development of high productivity, low cost floating PTPs would allow for a transformation of the current service pattern into a shuttle between two regional PTPs located in Gibraltar and Singapore (or other ports in the Malacca Straits). Such Gibraltar/ Singapore (Gib/Sig) shuttle service would require about half (!) the number of ships of an existing full Far East/North Europe rotation, or only five ships. Hence, if Maersk dedicates its fleet of 20 lots of 18,000 TEU on-order and present 10 lots of 15,000 TEU ships to the Gib/Sig express services, Maersk could provide six daily services between Asia and Europe. The annual capacity of these services would be about 10 million TEUs and the respective traffic generated at each PTP 20 million TEUs. A wide network of feeder services should be developed to distribute this traffic both in Europe and Asia. Figure 10 depicts the Gib/Sig shuttle concept, including feeder connections at its two PTPs.

The Gib/Sig will serve the main North European as well as some North American ports via feeders through the Gibraltar PTP. However, the resulting transit time will remain the same as that currently provided by direct service, or perhaps shorter, since the Gib/Sig eliminates en route ports of call and the PTPs shorten the port stay of ships. The reduction in transit time may even be more substantial for smaller North European ports presently feedered via North Europe ports, since the Gibraltar based feeder services, using ships of 3,000 to 6,000 TEUs, will be able to call directly at these ports. This would also apply to the Baltic ports, including the most remote ones, such as St. Petersburg, Tallinn and Helsinki, which could be served directly from the Gibraltar's PTP. All these ports will also be able to enjoy daily services, now confined to the major North European hubs. Altogether, the revised Fourth Revolution will substantially lower transport costs and improve level of services to most ports. The main losers will be the dethroned present hub ports losing their transshipment traffic to the PTPs. However, transshipment is not the primary traffic of these ports.

Similar PTP based shuttle services to the Gib/Sig could be developed between other pairs of global regions. Possible PTPs could be developed in Prince Rupert and Melford, Canada ; Freeport, Bahamas; the ports at entrances to Panama Canal and Suez Canal; Shanghai (Yangshan); and others. The two pre-requisites for PTPs, in addition to a strategic location, are a deep channel and a large, protected body of water for barge fleeting. Eventually, a global network of specialized PTPs and shuttle services connecting them will evolve, similar to the global grid of the original Fourth Revolution, but without the ERTW.

28,000 TEU Malacca-Max Ships

The Gib/Sig shuttle service is a dedicated service between two specialized PTPs; both could be based on a floating design. The floating design allows for locating the PTPs in deep water, since it does not require land reclamation for yard, with crane rails supported on piles or, more probably, caissons. For example, Algeciras' PTP, as shown in Figure 5, is located in water of 30 meters natural depth. The availability of deep water in both PTPs raises the possibility of employing dedicated deep draft ships for the PTP to PTP shuttle service.

In the case of Gib/Sig service, the ships' draft would be defined by the Straits of Malacca, or the ships could be Malacca-Max (MalMax). These MalMax ships could have similar dimensions to Maersk's Triple E, except for their deeper draft. Accordingly, the MalMax dimensions could be 400 by 60 by 21 meters, resulting in 245,000 deadweight tonnage. This is 36 percent larger than the 180,000 deadweight tonnage of the Triple E, and an equivalent container capacity of 24,500 TEUs (18,000 by 1.36) - twice the size of the 12,500 TEU NPX. If the ship length is extended to 460 meters, the capacity of the MalMax could reach 28,000 TEUs (!).

Summary observations

Making predictions for the volatile liner shipping industry is risky for the short-term; it is immeasurably more risky for the long-term, the subject of this paper. A case in point is my 1999 prediction for a forthcoming Fourth Revolution based on ERTW and extensive transshipment triggered by the 2014 expansion of Panama Canal. It seems now that the ERTW is unlikely to be developed because of the size of the expanded Canal. Likewise, my prediction of extensive transshipment also failed to be realized, thus far, despite the dramatic increase in ship size. Multi-porting and direct services still dominate Asia/Europe, the world's major trade routes. I believe that the dominance of direct services is short-term, the result of a temporary excess in ship supply and, mainly, the inability of existing terminals, even the most technologically advanced ones, to provide cost effective services to transshipment traffic due to their focus on gateway traffic.

The general concept underlying the Fourth Revolution is transformation of the current service pattern into a rationalized and integrated network of mother and feeder services. While the concept is still valid, it requires a revision. The revised Fourth Revolution, described in this paper, is based on a series of bi-regional, dedicated shuttle services between specialized PTPs, with each service tailored to the specific needs of its trade route, instead of the inclusive ERTW of the original Fourth Revolution. The separate shuttle services are then linked together at these PTPs, to form a global grid of shipping services, similar to that envisioned by the original Fourth Revolution but, again, without the ERTW and its multiple transshipments. The recent increase in ship size, emergence of dedicated regional shuttles in the Asia/Europe trade and, especially, the formation of "super alliances" appear to prepare the ground for the revised revolution. However, as was the case with the original revolution, the revised one is critically dependent on the development of specialized PTPs for which this paper presents a unique, floating design.

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Ashar, A., The Fourth Revolution, Containerization International, December 1999 and January 2000. See: www.asafashar.com.

Ashar, A., Revolution #4, Containerization International, December 2006. See: www.asafashar.com.

The concept was presented in a public seminar on long-term developments of liner shipping, which was part of the Port of Algeciras strategic plan.

Michael Jordan of Liftech Consultants Inc. proposed a similar design. See: www.liftech.net.

Prof. Niko Wijnolst and a team at Delft University studied a shuttle service by Malacca-max ships between Singapore and Rotterdam, although Rotterdam is mainly a gateway port. See: Wijnolst, N., Malacca-max 2, Container Shipping Network Economy, DUP Satellite, 2000. Capt. Yigal Maor presented a similar system based on a Mediterranean hub in TOC 2000.

Assuming: 20'000, two days for Suez, two days for PTPs handling and one day for slack.

An interesting application of the floating design will be for a barge to rail transfer terminal.

The dedicated, two port service raises the option of constructing LNG-fueling installations to allow the deployment of LNG-powered ships.

The permissible draft of Suez Canal is 66 foot (20.1 meters) and the largest allowed ship is 240,000 deadweight tonnage, with plans for further deepening, mainly geared toward large tankers.

ABOUT THE COMPANY

The National Ports and Waterways Initiative (NPWI) is a program of the University of New Orleans' Transportation Institute. NPWI was established in 1983 at Louisiana State University and since then has participated in numerous studies and projects, specializing in ports, inland waterways shipping, short-sea and deep-sea shipping, intermodal transportation systems, dry ports, institutional reforms and port legislation.

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